

AbstractID: 3132 Title: The effects of aperture size on low-energy brachytherapy
S_k measurements

Purpose: To experimentally determine the angular dependence of ¹²⁵I and ¹⁰³Pd interstitial brachytherapy seed air-kerma strength measurements with a large-volume ionization chamber and compare with Monte Carlo calculations.

Method and Materials: A Variable Aperture Free Air Chamber (VAFAC) has been constructed for making air-kerma rate measurements of low-energy photon emitting sources with photon energies up to 70 keV. Its underlying principle is that the air-kerma rate at a given point is proportional to the increment of ionization per increment of chamber volume at chamber depths greater than the range of secondary electrons originating in the entrance electrode. A unique feature of the VAFAC is its variable aperture stand, which accommodates five apertures with half angles ranging from 4 to 18 degrees. The US primary air-kerma strength standard is the National Institute of Standards and Technology Wide Angle Free Air Chamber (NIST WAFAC), which has a single fixed aperture size corresponding to a half-angle of 7.6 degrees. Relative air-kerma rate measurements have been completed for one seed type with all five aperture sizes. Additionally, MCNP5 particle transport has been used to theoretically determine the expected relative ionization with these aperture sizes.

Results: It is shown that the new VAFAC is capable of making air-kerma rate measurements for low-energy brachytherapy sources with a noise floor of 1-2 fA. The results from the first seed type indicate that varying the angle from 4 to 18 degrees yields up to a 5% change in the final air-kerma strength determination.

Conclusion: This work shows the capability of the VAFAC to experimentally measure the effects of ¹²⁵I and ¹⁰³Pd interstitial brachytherapy seed in-air anisotropy on a large angular measurement.